Strain and Flex Relief for I/O Interconnects

Strain and flex relief as part of the overall interconnect design should be a major consideration for designers.

By Steve Burk

Strain relief is often an overlooked area of design as it crosses the boundary between the assembly of the interconnect components and the cable. Strain relief and flex relief are terms that are frequently interchanged and mis-used. Wire and cable manufacturers can contribute to flex relief by developing high flex designs, but they cannot contribute to strain relief at the contact and wire termination area or flex relief at the cable exit or entry points in the final assembly.

Figure 1. One-directional flex relief.

Cable assemblies involve at least two terminated ends. The external connection point, such as a mini-DIN connector at the end of a mouse cable, and the internal connection point, where the cable terminates to a device, such as the other end of a mouse cable where it passes through a shell and is terminated at the PCB.

Strain relief in an interconnect component can be defined as internal stress relief at the termination point or flex relief at the cable exit area. Internal to a connector or termination point, such as a breakout transition, is the point at which the wires are terminated to contacts or other wires. Many devices require the addition of strain relief in this critical area. Many connectors provide this in the connector design itself, such as the insulation support area of a contact and the wire bar clips used on insulation displacement connectors. However, other devices, because of other mechanical considerations, require additional strain relief. Overmolding the contact and wire termination area can improve the pull-force performance, typically by a factor of two to three times. It is common for 40-60# pull-force to be achieved by simply overmolding.

The point at which a cable exits a connector body or other component can be a critical failure point because of repeated flexing. Typically, flex life of the cable can be improved up to four times the manufacturer's rating by incorporating an overmolded flex relief. The overmolded flex relief is common in devices that have high flex rates, such as point-of-sale scanners and medical devices.

Design Considerations

The primary design considerations for stationery applications are pull-force requirements between the cable and wire terminations, and mechanical protection for the cable as it passes through a panel cutout or other exit point. Interconnect components that see little or no movement when installed for their intended use often require little or no additional strain or flex relief at the connector terminations as the basic connector and backshell design incorporates these features into the original design.

Figure 2. Multi-directional flex relief.

Cables that pass through an opening require some form of protection for the cable and a method of attachment whereby the cable does not pull out of the device. This can be accomplished as simply as installing a tie-wrap at the inside edge of the cable, or a compression fit between the inner surfaces of the device and the cable jacket, or the use of a discrete slip-on or molded-on grommet.

Custom solutions need to be used when the cable is not within the connector manufacturer's design limits. The options are endless, depending on the components used and the performance required. Options such as Kevlar or stainless-steel strength members used in the cable to achieve pull-force compliance are one example.

Flex applications typically are customized to a specific design requirement. Applications where flex life performance is important are devices that have constant flexing such as point-of-sale scanners, where design for flex life is in the hundreds of thousands flexures, and portable devices such as portable digital assistants (PDAs) and medical devices, where typical design considerations include a 50,000 to 100,000 life cycle range.

In situations such as these, the design of the flex relief and its attachment to the cable is critical. Devices that typically are used on a flat desktop or tabletop environment frequently require a flex relief that only moves in one direction. This is a simpler design solution than a multi-directional movement. Devices that require a multi-directional movement need a wider variety of ribbed designs to maximize the increase in flex life for the finished cable (see Figures 1 and 2).

The strain relief can be solid or ribbed. There are inherent advantages and disadvantages to both. Solid designs work with a wider range of cable diameters at a lower cost, while ribbed designs are specific to a particular cable diameter but provide better flex relief. A compromise style is a solid design with undercut rib sections that provide for some flexing of the strain relief, but at the same time provides for the possibility of various cable diameters and the appearance of ribs.

In addition to strain relief design, the choice of materials is paramount to the performance of the final product. Typical material selections are thermoplastics such as PVC, ABS and nylon, santoprene and polyurethane, with shore hardness from A-50 to A-90.

Assembly

Many connector and off-the-shelf strain and flex reliefs are suitable as-is for the application. Connector manufacturers incorporate varying degrees of design into their products. The choices are screw-on type clamps to anchor the connector and cable together or discrete molded-on grommets designed to fit the connector shells (see Figure 3).

Figure 3. Mechanical attachment.

Figure 4. Round slip-on flex relief.

Typically, snap-on or slip-on strain reliefs are mechanically attached to the connector body either with a compression snap or locating flange at the exit point (see Figure 4). Connector and cable accessory manufactures provide a limited product offering of off-the-shelf strain relief products. The range of options in both cable diameter and physical dimensional requirements make it almost impossible to provide a product for every application.

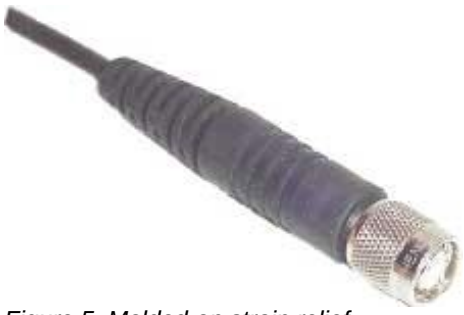

Figure 5. Molded-on strain relief.

Molded-on strain reliefs typically are customized and an integral part of an overmold used for an interconnect component (see Figure 5). Good design includes attention to internal strain relief for the wire terminations and flex relief suitable for the application. Frequently, it is possible to adapt an otherwise unsuitable connector for a specific application into a superior product in both cost and performance because of the use of the overmold.

Conclusion

Strain relief and flex relief as part of the overall interconnect design is a major consideration for engineering and assembly designers. Many times, the off-the-shelf solutions are more than adequate. With the vast and seemingly endless applications that use cables and connectors, failures caused by problems with the cable or termination are abundant. It is important to take into account the intended use of the device and incorporate the right combination of electrical and mechanical design into the interconnect cables and components.

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